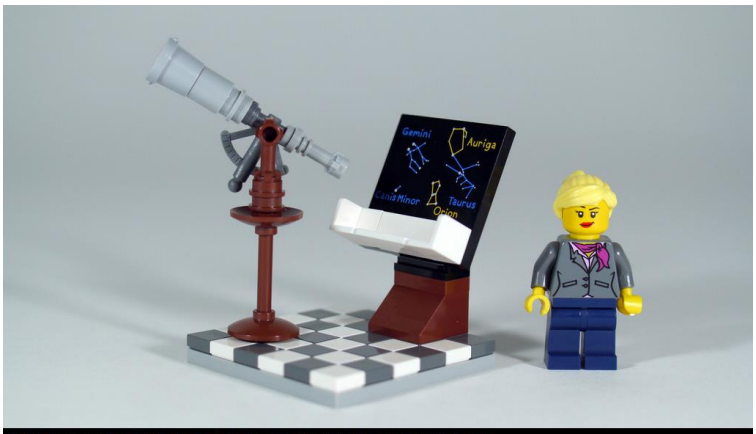
FOREST LEARNING

Teacher

Year 11 Earth and Environmental Science

Depth Study – Module 2

Making and using Scientific Models



Contents

Teacher Overview....2
Stage....2
Syllabus Links....2
NSW Syllabus for the Australian Curriculum....2
Content Outcomes of Tasks....2

Lesson Activities....3
Activity 1: Locating Plate Boundaries on a Geological Map....3
Activity 2: Geological features at Plate Boundaries – Modelling Normal, Reverse and Transform Faults....4
Activity 3: Plate Boundary Model....7
References....8

Sample Answers....9
Activity 1: Locating Plate Boundaries on a Geological Map....9
Activity 2: Geological features at Plate Boundaries – Modelling Normal, Reverse and Transform Faults....10
Activity 3: Plate Boundary Models in groups....14
Creative Commons License....14

Teacher Overview

During this lesson, students will construct a scientific model and evaluate the benefits and limitations of these models. After a brief introduction to the location and type of plate boundaries found around the Earth, students construct models that demonstrate the processes and the topographic and geological features that occur at plate boundaries. These models are presented to the class and students engage in peer feedback through an evaluation of the models.

Stage

Year 11 Earth and Environmental Science

Syllabus Links

Select, construct and use appropriate representations (models), to communicate conceptual understanding (ACSES006).

Plate tectonic processes generate earthquakes, volcanic eruptions and tsunamis; the occurrence of these events affects other Earth processes and interactions (for example, ash clouds influence global weather) (ACSES099).

NSW Syllabus for the Australian Curriculum

A student:

- Develops and evaluates questions and hypotheses for scientific investigation (EES11/12-1)
- Selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media (EES11/12-4)
- Communicates scientific understanding using suitable language and terminology for a specific audience or purpose (EES11/12-7)

Content Outcomes of Tasks

Inquiry question: What occurs at plate boundaries?

Students:

Use geological maps of the Earth to locate boundary types and model the processes that have contributed to their formation, including: (ACSES006, ACSES035, ACSES099)

- divergent boundaries
- convergent boundaries
- transform boundaries

Plate Boundaries and Tectonic Structures

Inquiry question: What are the geological and topographic features that have resulted from plate tectonics at each plate boundary type?

Students:

Model types of plate boundaries showing the dominant topographic and geological features, including: (ACSES006)

- divergent boundaries: rift valley, mid-ocean ridge, normal and transform faults,
- convergent boundaries: mountain range, trench, reverse faults and folds.

Lesson Activities

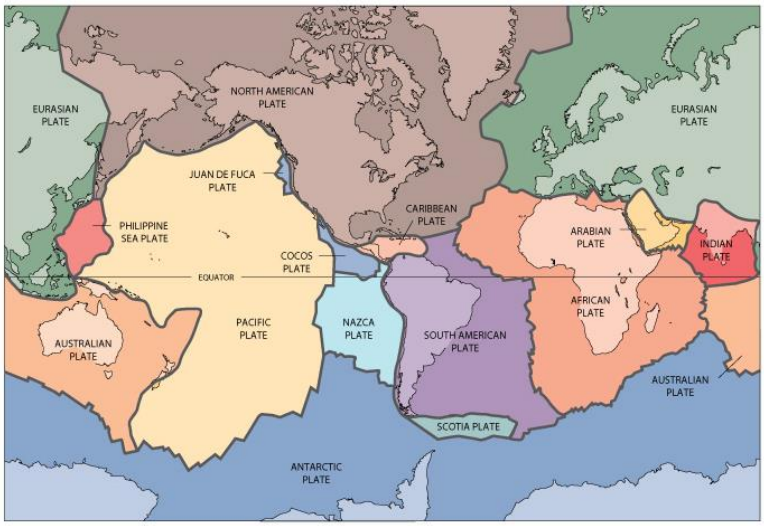
Activity 1: Locating Plate Boundaries on a Geological Map

(approx. 45 minutes)

- Students are provided with a map of the Earth showing tectonic plates (NB: this would be better printed in black and white, so students can use coloured pencils on the map).
- A web link to a video, Tectonics of Planet Earth, is provided and can be watched as a class or individually depending on the teacher's preference and school resources.
- Prior to watching the clip, students choose 3 coloured pencils and complete the key found under the map.
- As they watch the video clip, and examples are provided, students (with teacher assistance) can mark examples of the three different plate boundaries on the map of the Earth.

Source: Tectonics of Planet Earth (15 minutes)

URL: https://www.youtube.com/watch?v=Kg_UBLFUpYQ



Source: *USGS* - https://pubs.usgs.gov/publications/text/slabs.html Historical Perspective Tectonic Plates.

MAP KEY

Divergent Boundary =

Convergent Boundary =

Transform Boundary =

- After viewing the video clip, a class discussion could be used to generate answers to the summary table (page 3 of the student workbook).
- The following map could be used to assist the class discussion:

  Source: BC Open Textbooks, Physical Geology
  URL: https://opentextbc.ca/geology/chapter/10-4-plates-plate-motions-and-plate-boundary-processes/

Activity 2: Geological features at Plate Boundaries – Modelling Normal, Reverse and Transform Faults. (approx. 45 minutes)

The aim of this lesson is to introduce forces that act on plate boundaries and the faults that result from these forces. Students will then match the faults to the three plate boundaries studied in Activity 1. These geological features can then be added to the plate boundary models that students will make in Activity 3 where applicable.

During this activity the teacher will demonstrate tension and compression forces using play dough, or silly putty could also be used. The play dough will represent lithospheric rock. The students will make a prediction about what will happen when the dough is squeezed together, pulled apart and then moved to show a shear force. The teacher will then either get students to have a turn at squeezing and then pulling the play dough apart individually or as a demonstration by one student depending on available resources. Two students will demonstrate the shear force by holding the play dough together, standing next to one another facing opposite directions and walking a step away from each other.

After these demonstrations, students will then brainstorm at what plate boundaries each of these forces occurs.

Below are the student instructions for this activity as per page 5 of the Student Workbook. The Student Workbook also contains spaces for student responses.

Your teacher will show you a ball of dough. The dough represents rock.

a. In the space below, make a prediction, what do you think will happen when the ball of dough when it is squeezed between your hands? Was your prediction correct?

This stress is called COMPRESSION, the dough has become squeezed into less space and changes the dough by shortening it.

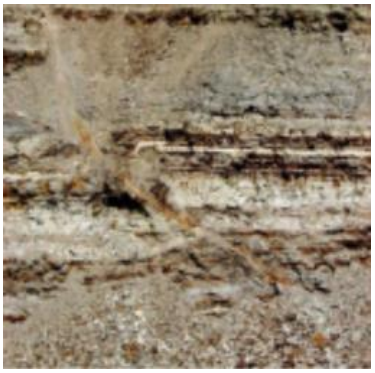
b. What type of plate motion do you think results in compression of rocks?
c. Make a prediction about what you think will happen to the dough when it is stretched.

This stress is called TENSION and it changes the dough by lengthening it.

d. What type of plate motion do you think results in a tension force acting on rocks?
e. Form pairs with another student. Stand next to each other and hold a ball of dough between you using your fingertips. One will face the board and the other will face the back of the classroom. What do you think will happen if they walk away from each other?

This is called SHEAR stress. Transform plate motion shears rocks.

The outer part of the Earth is cold compared to the other layers of the Earth. When it is stressed it tends to break. The breaks are called faults. Below, you can see some examples of different types of faults in rocks:



Images source: https://opentextbc.ca/geology/chapter/12-3-fracturing-and-faulting/

Continuation of teacher instructions:

In the next part of this activity, the teacher will start by showing the students a block with rock stratum and a fault line (can be premade wooden blocks or can be made using Internet instructions – see below). The students will draw and label the fault line, overhanging wall and footwall.

Background information on fault types and movement:

- Source: BC Open Textbooks, Physical Geology, Fracturing and Faulting URL: https://opentextbc.ca/geology/chapter/12-3-fracturing-and-faulting/ under the heading faulting.

The teacher will then use premade models to demonstrate a normal, reverse and transform fault. If the school has access to wooden block models they could be used.

Alternatively, paper models or sponge models that could be made prior to the lesson can be found at the following sites:

- Source: Type of faults, faults analysis group
  URL: https://www.fault-analysis-group.ucd.ie/papermodels/models/faults.html
- Source: Arguing Causes of Faults and Folds – Sponge fault Model, IRIS.
  URL: https://www.iris.edu/hq/inclass/lesson/sponge_faults

An example of the work student's will have to complete for each model is found within the Sample Answers for this section on pages 11-13 below.

Activity 3: Plate Boundary Model (approx. 90 minutes)

During this activity, students will work in groups to construct a plate boundary to model. There will be 6 models that will need to be constructed.

1. Divergent oceanic-oceanic
2. Divergent continental-continental
3. Convergent oceanic-oceanic
4. Convergent continental-oceanic
5. Convergent continental-continental
6. Transform

The topographic and geological features that need to be included as mandated by the syllabus are:

- **divergent boundaries:** rift valley, mid-ocean ridge, normal and transform faults
- **convergent boundaries:** mountain range, trench, reverse faults and folds

Students should be supplied with as many craft items as possible. There are a number of ways the models can be made with many ideas found on the Internet. Some ideas are given below, and it is suggested these be shown to students before they make their models to give them some ideas. The students can then decide on the type of model they will be constructing depending on their strengths.

Examples of the Models:

Divergent Plate Boundaries/Sea floor spreading

- Source: Divergent plate boundary / sea floor spreading
  URL: https://www.youtube.com/watch?v=QY8XqTDd3fs

Plate Boundary Claymotion (example of technology to demonstrate the model)

- Source: Divergent plate boundary / sea floor spreading
  URL: https://www.youtube.com/watch?v=QY8XqTDd3fs

Plate Boundaries Stop Motion (example of using technology to demonstrate the model)

- Source: Plate boundaries Stop Motion
  URL: https://www.youtube.com/watch?v=cFt_KLpQWzw

Plate Tectonics (shows a good example of using a key and labeling features)

- URL:
  https://i.pinimg.com/originals/8e/e4/2c/8ee42c84430ed1589f89c216b4edefea.jpg

Convergent Model

- URL: http://4.bp.blogspot.com/-nmIsAxGYhGU/TaIOg_6vIjI/AAAAAAAAAA0/xDi8l8HG3SM/s1600/Convergent%20Model.JPG

Students then display the models. Each student completes an evaluation (provided on the student worksheet) of their model and the other plate boundary models.

References

Activity One

1. Historical Perspective Tectonic Plates. USGS. https://pubs.usgs.gov/publications/text/slabs.html. September 2011. Accessed 3 October 2017.
2. Tectonics of Planet Earth. YouTube. https://www.youtube.com/watch?v=Kg_UBLFUpYQ. October 2013. Accessed 3 October 2017.
3. Physical Geology BC Open Textbook. Steven Earlehttps://opentextbc.ca/geology/chapter/10-4-plates-plate-motions-and-plate-boundary-processes/ Accessed 3 October 2017.

Activity Two

1. Physical Geology BC Open Textbook. Steven Earle https://opentextbc.ca/geology/chapter/12-3-fracturing-and-faulting/ Accessed 3 October 2017.
2. Paper Models for Geology Mapwork. Types of Faults. https://www.fault-analysis group.ucd.ie/papermodels/models/faults.html September 2012. Accessed 7 October 2017.

3. Arguing the Case of Faults and Folds. IRIS. https://www.fault-analysis group.ucd.ie/papermodels/models/faults.html September 2017. Accessed 7 October 2017.

Activity Three:

1. Divergent Plate Boundaries/Sea floor spreading https://www.youtube.com/watch?v=QY8XqTDd3fs January 2016. Accessed 7 October 2017
2. Plate Boundary Claymotion. https://www.youtube.com/watch?v=QY8XqTDd3fs. April 2014. Accessed 7 October 2017.
3. Plate Boundaries Stop Motion https://www.youtube.com/watch?v=cFt_KLpQWzw June 2010. Accessed 7 October 2017.
4. Plate Tectonics. Source Unknown. https://i.pinimg.com/originals/8e/e4/2c/8ee42c84430ed1589f89c216b4edefea.jpg. Accessed 7 October 2017
5. Convergent Model. Source Unknown. http://4.bp.blogspot.com/-nmIsAxGYhGU/TaIOg_6vIjI/AAAAAAAAAA0/xDi8l8HG3SM/s1600/Convergent%20Model.JPG. Accessed 7 October 2017.

Sample Answers

Activity 1: Locating Plate Boundaries on a Geological Map

KEY: Will depend on colours used by students

Plate Boundaries and their location

Boundary Type	Direction of Movement	Location Examples
Divergent Oceanic-oceanic		Mid Atlantic Ridge
Continental-continental		African Rift Valley
Convergent Oceanic-oceanic		Indonesia
Oceanic-continental		Andes Mountain Range, South America
Continental-continental		Himalayas
Transform		San Andreas Fault USA

Answers to the location of the different plate boundaries can be found on the website.

- Source: Plates, Plate Motions, and Plate-Boundary Processes. Open Textbook. URL: https://opentextbc.ca/geology/chapter/10-4-plates-plate-motions-and-plate-boundary-processes/

Activity 2: Geological features at Plate Boundaries – Modelling Normal, Reverse and Transform Faults.

a. In the space below, make a prediction for what you think will happen to the ball of dough when it is squeezed between your hands? Was your prediction correct?

Will be an individual student response

b. What type of plate motion do you think results in compression of rocks?

Convergent boundary – two plates coming together

c. Make a prediction about what you think will happen to the dough when it is stretched.

Will be an individual student response

d. What type of plate motion do you think results in a tension force acting on rocks?

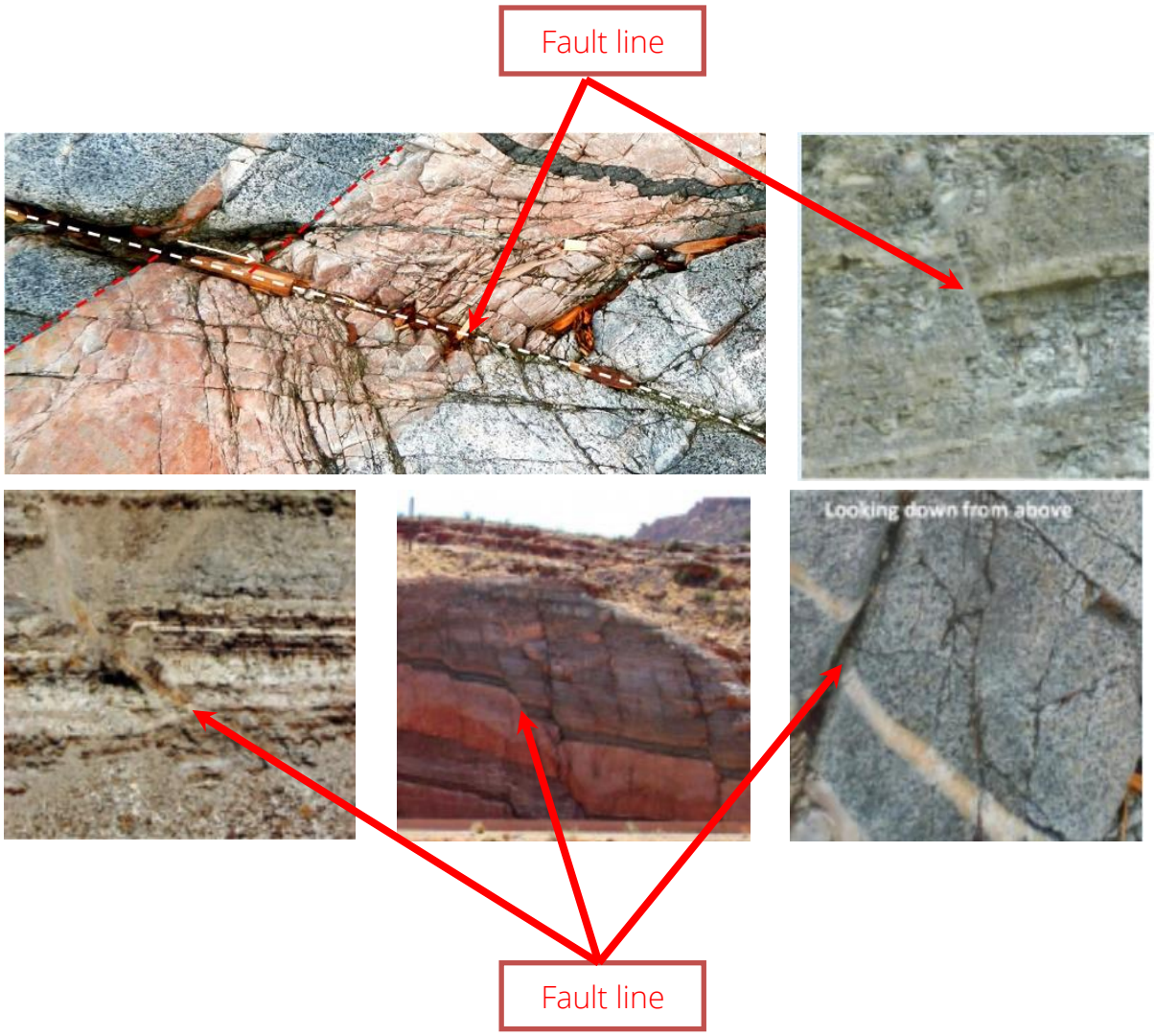
Divergent boundary – two plates moving apart

e. What do you think will happen if they walk away from each other?

Will be an individual student response

The outer part of the Earth is cold compared to the other layers of the Earth. When it is stressed it tends to break. The breaks are called faults. Some pictures of different types of faults in rocks can be seen in the pictures below.

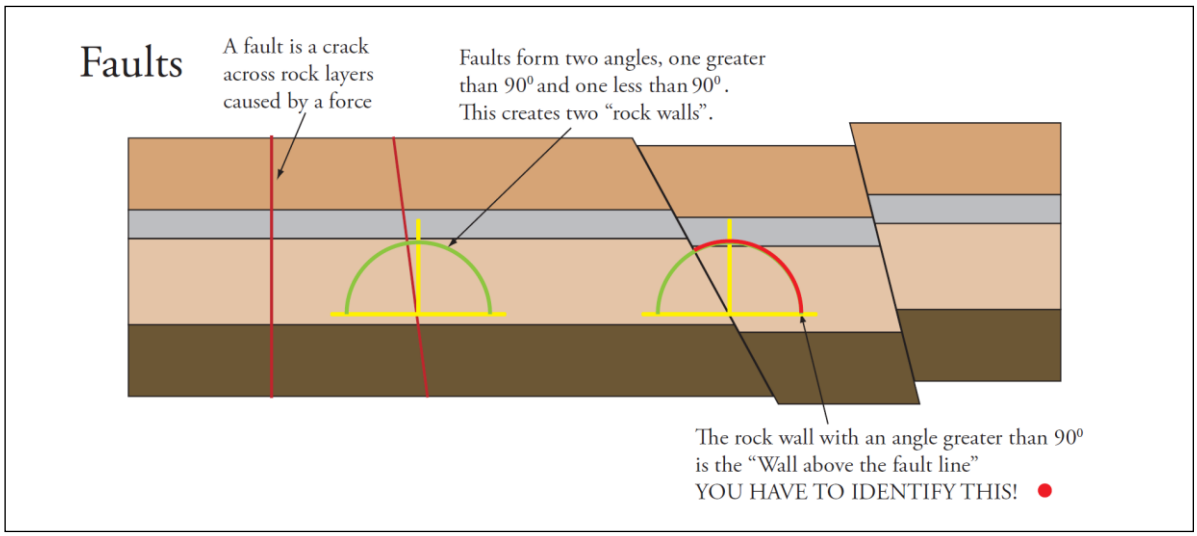
Teacher should point out fault lines in the rock and introduce the term rock stratum.



Images source: https://opentextbc.ca/geology/chapter/12-3-fracturing-and-faulting/

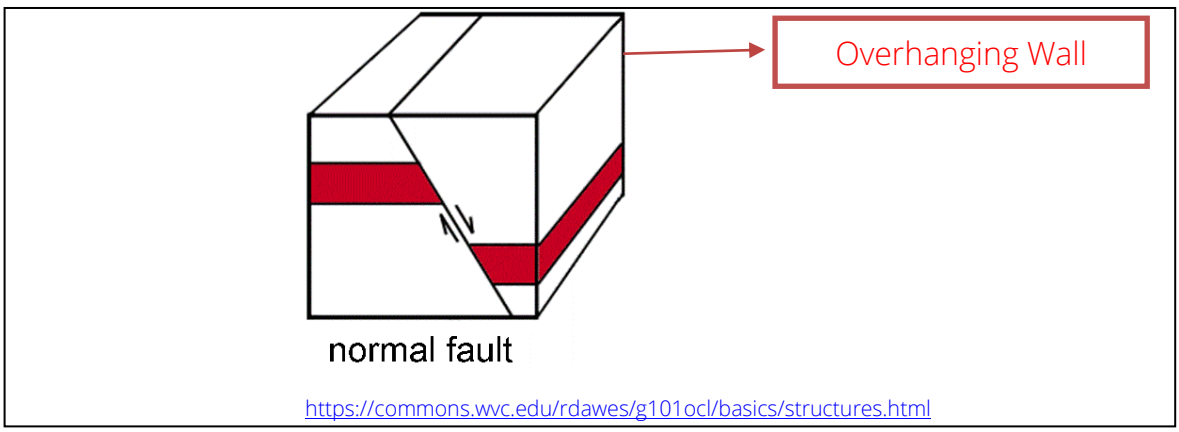
1. Rock with Fault line

Draw and label a cross section of rock stratum showing the fault line, hanging wall and footwall



2. Normal Faults

Draw or take a photo of a rock with normal faults and paste it in the space below. Label the model and the movement of the fault in the space below.



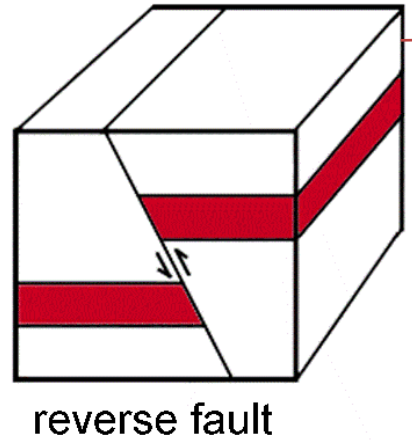
Type of Force: Tension

Movement of overhanging wall: Down

Plate Boundary Fault is located: Divergent e.g. Mid Atlantic Ridge

3. Reverse Fault

Draw, or take a photo of a real reverse fault example, and paste it in the space below. Label the model and movement of the fault in the space below.



https://commons.wvc.edu/rdawes/g101ocl/basics/structures.html

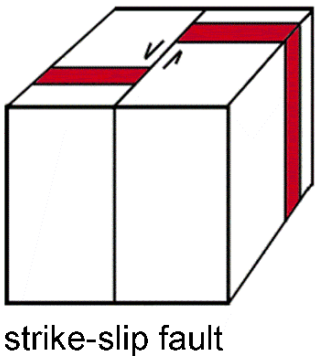
Type of Force: Compression

Movement of hanging wall: Up

Plate Boundary Fault is located: Convergent e.g. Indonesia

4. Transform Fault – Strike-slip fault.

Draw, or take a photo of a real transform fault – strike-slip fault example, and paste it in the space below. Label the model and movement of the fault in the space below.



https://commons.wvc.edu/rdawes/g101ocl/basics/structures.html

Type of Force: Shear

Movement of hanging wall: N/A

Plate Boundary Fault is located: Transform e.g. San Andreas Fault

Activity 3: Plate Boundary Models in groups.

Evaluation: All the answers to the evaluation will depend on the models constructed and individual student responses.

Questions on the model made by your group:

1. List the features of plate boundaries that should be included in a model
2. What plate boundary did your group construct?
3. Place a picture in the space below of your group's model
4. List the features of plate boundaries your model shows.
5. What features of plate boundaries are not shown on your model?
6. If you made your model again, what improvements would you make?

Evaluation of Groups Models:

All the answers to the evaluation will depend on the models constructed and individual student responses.

Question

This could be given as a take home task that is collected for feedback

Evaluate which model was the most effective at representing a plate boundary.

References

1. Historical Perspective Tectonic Plates. USGS. https://pubs.usgs.gov/publications/text/slabs.html. September 2011. Accessed 3 October 2017.
2. Tectonics of Planet Earth. Youtube. https://www.youtube.com/watch?v=Kg_UBLFUpYQ. October 2013. Accessed 3 October 2017.
3. Image Play Dough https://pixabay.com/en/play-doh-plasticine-toys-841826/ July 2015. Accessed 7 October 2017
4. Images of Faults. Geology 101 – Introduction to Physical Geology. https://commons.wvc.edu/rdawes/g101ocl/basics/structures.html September 2013. Accessed 7 October 2017.
5. Physical Geology BC Open Textbook. Steven Earle https://opentextbc.ca/geology/chapter/12-3-fracturing-and-faulting/ Accessed 3 October 2017.